LOWELL OBSERVATORY, PLUTO DOME
1400 W. Mars Hill Road
Flagstaff
Coconino County
Arizona

HABS NO. AZ-206-C

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPY OF DRAWING

Historic American Building Survey
National Park Service
Department of the Interior
P.O. Box 37127
Washington, DC 20013-7127

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HISTORIC AMERICAN BUILDINGS SURVEY

LOWELL OBSERVATORY, PLUTO DOME
HABS No. AZ-206-C

Location: Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, Coconino County, Arizona. The Pluto dome is the northern most building on the observatory site and is reached by a north east to south west running path known as the "Pluto Walk." The path connects the Pluto dome with the Administration Building.

Present Owner: Percival Lowell Estate, Lowell Observatory.

Present Occupant: The telescope has been removed and the Pluto Dome is currently vacant.

Present Use: The Pluto dome has been part of the Lowell Observatory complex since its construction in 1928. While it is no longer used for astronomical observations, it is a highly visited tourist attraction on the site. It is currently being restored.

Significance: The Pluto dome was designed and constructed by Stanley Sykes and Edward C. Mills in 1928-29 to house the 13-inch telescope that was donated to the Observatory by A. Lawrence Lowell, Percival Lowell's brother and former Harvard University President. This telescope was instrumental in the discovery of the planet Pluto.

Historian: Rebecca Jacobsen, HABS, summer 1994

PART I. HISTORICAL INFORMATION:

A. Physical History:

1. Date of Erection: Letters written between V.M. Slipher, Lowell Director, and Roger Lowell Putnam, Lowell Trustee, date the construction of the Pluto dome to 1928-29. According the letters, work began in early April 1928. Although the building itself was completed by September 30, 1928, it was not ready for use until February 1929 when the telescope lens was delivered and installed.

2. Architect: The Pluto dome was designed and constructed by Stanley Sykes and Edward C. Mills. Sykes, born in England but a Flagstaff resident since 1886, had been a Lowell Observatory instrument maker and handyman since the Observatory's founding in 1894.[1] E. C. Mills came to Flagstaff in 1909. A native of Canada, Mills was an excellent cabinetmaker. He applied his woodworking talents to a number of projects around Flagstaff and the Lowell Observatory.[2] He was employed by the Observatory from 1915-1932.[3]

3. Original and subsequent owners, occupants, uses: Since its completion in 1929, the Pluto dome has been part of the Lowell Observatory complex, under the ownership of the Percival Lowell Estate. It has been used by Lowell astronomers, notably Clyde Tombaugh, who is credited with the discovery of Pluto.[4] The dome is no longer used for astronomical studies, but is a popular visitor attraction at the Observatory.

4. Builder, contractor, suppliers: The Pluto dome was designed by Stanley Sykes, Observatory handyman, and constructed under the direction of Sykes and Edward C. Mills, another Observatory employee.[5] The lumber for the building was supplied locally by the Arizona Lumber and Timber Company of Flagstaff, Arizona.[6] The 13-inch "Pluto telescope" was purchased with funds donated by Percival Lowell's brother, A. Lawrence Lowell.[7] Alvan Clark and Sons of Cambridgeport, Massachusetts, supplied the telescope lens.[8] Stanley Sykes designed and constructed the telescope's mountings and piers.[9] A worm wheel drive for the telescope was made by Browne and Sharpe.[10]

5. Original plans and construction: The Pluto dome has changed little in appearance since its completion. It was built to resemble the Clark dome, the first permanent dome at the Observatory. The Pluto dome was constructed of local materials, notably ponderosa pine for framing and malpais volcanic rock facing on the base. V.M. Slipher described the new telescope dome as being a smaller version of the Observatory's Clark telescope dome. While the design of the Clark dome was unusual with its inverted bucket shape, Slipher felt that the design had worked well in the past and that it would be cheaper and easier to use the old design rather than try to come up with a new one.[11]

The frame of the dome was to be of wood covered with galvanized iron, and the lower half was to be made of

concrete faced with rough local stone. The stone facing was to be similar to that of the 1916 Administration Building.[12]

Photographs of the Pluto dome taken during and shortly after construction show the building to be similar in shape to Clark dome, which is cylindrical, with the top dome in the shape of an inverted bucket. The Pluto dome is, however, considerably smaller. Further, the Pluto dome was built with a ground floor and second floor. The Clark dome is a single large room open to the ceiling.

6. Alterations and additions: The Pluto dome has had no additions, and few alterations. Historically sensitive alterations have been made since the late 1980s in an effort to restore the building. The interior wood staircase has been replaced with a new staircase patterned after the original. The original two-light casement windows around the first floor have been replaced with single pane casement windows.

1970: The greatest change to occur within the building was the removal of the original 13-inch telescope in 1970. The telescope was sent to the Observatory's "dark sky" site at Anderson Mesa and was replaced with another telescope.[13] In 1994, the replacement telescope was removed to an exhibit in the Observatory's new Steele Visitors Center and the Pluto telescope was brought back to the Lowell Observatory for re-installation.[14]

1990: An addition to the landscape around the dome was completed in 1990. The "Pluto Walk," a concrete path following the trail Lowell astronomers made between the Administration Building and the dome, has become popular with Observatory visitors. The path has nine signs, each with a description of one of the nine known planets in our solar system, leading up to Pluto, the sign nearest the dome.[15]

B. Historical Context:

Of the nine known planets in our solar system, only one of them was discovered by an American Observatory. Pluto, the outermost planet, was discovered at the Lowell Observatory in Flagstaff, Arizona, in 1930. While it was a young assistant by the name of Clyde Tombaugh who finally singled out the planet on a photographic plate showing hundreds of stars, it was years of research by Percival Lowell and

others at the Observatory that made the discovery possible.[16]

A Planet Beyond Neptune

Percival Lowell postulated as early as 1905 that there was at least one, if not two planets beyond Neptune. In calculating the rotation period of Neptune, Lowell and others realized that there were discrepancies in the rotation that could only be explained by the presence of another large heavenly body. Lowell began his search for a trans-Neptunian planet in 1905 not by looking through his telescope, but by making a series of complex mathematical calculations to predict its likely position. Lowell even hired extra help to make these calculations.[17]

Once the probable location of the theorized planet was determined, the next step was a painstaking search of the skies. Photography was an important tool in this process. Pairs of photographs were made of sections of the sky over a period of a few days. When the pairs of photographs of the same section of sky were compared, stars would appear to be stationary, but a planet would appear to "jump," or move, because of its rotation. While this sounds simple, each plate contained hundreds of tiny points of light and each one had to be compared with its companion on the second photograph.[18] Until the Observatory was able to acquire a "blink comparator," this was a labor intensive task. Further complicating the process was the fact that asteroids also appeared to "jump" on the plates, undoubtedly causing a few false alarms.[19]

In the process of making photographic plates of the night sky, it quickly became apparent that the Clark 24-inch telescope was not the ideal instrument for making the photographic plates. Another telescope with a smaller objective would greatly benefit the search.[20] However, such a telescope was not purchased for several years, owing partly to the fact that the search for the ninth planet was suspended not once, but twice between 1905 and 1916. In 1911, Lowell became distracted with his Mars research, which was his "first love" and original reason for founding the Observatory. The search resumed in 1912, but Percival Lowell's death in 1916 halted operations once more.[21]

Other members of the Lowell Observatory staff continued with the work after the end of the First World War, but they were quickly reminded that the 24-inch Clark telescope was an ineffective searching tool. Percival Lowell had set a standard of always providing his Observatory with the most

technologically advanced equipment, however despite the fact that he provided money in his will for continuing operation of the Observatory, the staff had to wait several more years for a new telescope. Constance Lowell, Percival's widow, contested Percival's will, claiming that she should be in charge of the Observatory and estate instead of Guy Lowell, Percival's third cousin and appointed trustee. For the next decade, more money was spent on legal fees than on astronomical research. Constance even insisted that the Observatory employees take a pay cut. Eventually the courts found in favor of Guy Lowell, and he was granted control of the estate and the Observatory. By the late 1920s, things settled down once more on "Mars Hill."[22]

The interest in searching for a trans-Neptunian planet remained strong after Lowell's death and the need for a new telescope remained. As trustee, Guy Lowell began to make inquiries regarding a lens for a new telescope. He purchased three unfinished pieces of glass from Reverend Joel Metcalf of Taunton, Massachusetts, with the intent of having them made into a telescope. Unfortunately, Guy Lowell died in 1927, before anything further could be done with the glass.[23]

The New Trustee

Roger Lowell Putnam, Percival Lowell's nephew and the next trustee, facilitated the trans-Neptunian planet search more than anyone save for Percival Lowell himself. It was Roger Putnam who finally secured the much needed telescope to continue the project.[24] As the Observatory itself did not have enough money to purchase a telescope and build the appropriate dome and mountings, Roger appealed to A. Lawrence Lowell, Percival's brother and President of Harvard University. On June 30, 1927, Putnam wrote to Observatory Director Vesto M. Slipher:

Both you and Mr. Lampland will be particularly glad to hear that President Lowell of Harvard is going to give the Observatory the thirteen inch telescope. . . . The estimate for figuring the lens was $4,000 from Fecker, and I told Uncle Lawrence that, by rule of thumb, from that, the total cost of the instrument would not be over ten thousand dollars. I hope I am right, because I would hate to go back and ask him for any more.[25]

To the astronomers at the Lowell Observatory, the telescope itself was the most important part of the proposed telescope, mountings, and dome package. Several letters between V. M. Slipher and Roger Putnam describe in careful

detail what the new 13-inch telescope was to be like:

> The housing of the instrument need not be very costly as such an instrument is short of focus and so does not require a large shelter. A good driving clock with a good big worm wheel so as to give accurate running of the instrument are important features, and then a good sized guide telescope. This does not need to be of the most perfect figure as the more important quality brightness of image, rather than sharpness of definition, makes guiding more accurate and easy.[26]

Slipher was equally specific in his requirements for the telescope mountings:

> One feature of the mounting, however, is of very great importance, namely it must be mounted so as to allow passing through the meridian for all declinations without having to interrupt to shift the pointing of the instrument to the other side of the pier as would have to be dome with the usual equatorial mounting for stars north of the zenith. . . . In this case, the polar axis is rather long and supported at both ends with the declination axis mounted about midway of the polar axis. In this way the whole sky can be reached and the exposure can run right through the upper culmination of the object without any interruption. Such a mounting should not be costly to build.[27]

Constructing the Dome

Much of 1927 was spent in planning the dome, mountings, and telescope. After careful consideration it was decided that Alvan Clark and Sons of Cambridgeport, Massachusetts, makers of the Observatory's 24-inch refractor, would be the firm to create the objective lens for the new 13-inch telescope.[28] Stanley Sykes, Lowell Observatory instrument maker and general handyman since 1895, would design and build the special telescope mountings described by Slipher.[29] The dome to house it all would be a smaller version of the Observatory's 24-inch Clark telescope dome. Slipher described the plans in a December 3, 1927 letter to Roger Putnam. He wrote:

> The dome we think should be a smaller copy of that of the 24-inch refractor. That works and it is much easier to duplicate it than to design and build something different; besides to my mind that will give something good for less money than the hemispherical type.[30]

Had Lowell Observatory been constructed like other observatories of its time, the new Pluto telescope might have been mounted in the smaller room of a large, central observatory building. The concept of separate structures for separate instruments was beginning to be seen in the middle nineteenth century, but would not become standard practice until the twentieth century when more was known about the effects of structures on air turbulence and the quality of seeing.[31] At Lowell, all the telescope domes had been built as separate structures since the first permanent dome was erected in 1896, and the new Pluto dome would follow suit.

In March 1928 a site was selected for the new telescope and dome. It would be placed approximately 100 yards north and west of the administration building that had been constructed in 1916. This section of land had been leased to the Observatory by the Forest Service. According to V. M. Slipher, the site was satisfactory for observing and in addition, by constructing a building on that section of land the Observatory could better justify its need for the land.[32]

With the telescope objective ordered and the mountings being designed and constructed on site, construction of the dome could begin. V. M. Slipher noted to Roger Putnam on April 9, 1928 that:

> We have the work started on the building for the instrument. And hope to keep it moving forward. The iron sill for the dome has been ordered from Chicago. The rest of the dome will be framed of wood covered with galvanized iron. The building below the revolving dome will be of rough stone similar to this building. This is fairly fire resistant, is substantial and about as cheap as it is possible to build.[33]

By the end of September 1928, Slipher was able to report that the dome was complete, but there was still a bit of work to do on the mountings and a guide telescope was still needed. Like many construction projects today, Slipher and his crew at the Observatory ran into a few cost overruns. In his September 30 letter to Putnam, Slipher noted that "there were not funds sufficient" to pay some of the monthly bills. Slipher blamed the new construction and noted that, "it has called for expenditures in order to keep the work moving along." Among the expenditures listed in Slipher's letter were $100 to the Arizona Lumber and Timber Company, $100 for wiring on the new dome, and $100 for a tinner to roof the new dome.[34]

Discovering "Planet X"

In January 1929, a new assistant by the name of Clyde Tombaugh arrived at Lowell Observatory to continue the task of making new plates and to take on the tedious process of comparing the plates for "jumping" points of light. The first new photographic plates were made with the new telescope late in December 1928, and Tombaugh began making regular night trips to the telescope to continue the search for "Planet X."[35]

A little over a year later, in February 1930, Tombaugh found what astronomers at Lowell had been looking for since 1905. For the next few weeks, astronomers C. O. Lampland and V. M. Slipher ran further tests to confirm Tombaugh's "blink sighting." On March 13, 1930, C. O. Lampland, while presenting the Lowell Memorial prize at Northern Arizona State Teachers' College, announced to the group of students that the ninth planet had been found.[36] Roger Lowell Putnam had been given the honor of naming the new planet, and on the suggestion of a school girl from England, the name "Pluto" was selected. The name was appropriate as it continued the tradition of naming planets for Greek and Roman gods, and the first two letters of Pluto happened to be Percival Lowell's initials. Putnam felt it was important to give credit to the man who's research and calculations led to the discovery.[37]

Use of the "Pluto dome" and telescope did not stop with the discovery of that planet. Since so much work had been done to photographically map the skies during the search, it was decided that the process should continue. After the discovery of Pluto, and additional 1440 plates were made, and Tombaugh continued to "blink compare" the plates "until about eight-tenths of the entire sky paralleling both sides of the ecliptic were searched."[38] A few years later, Henry Giclas, another young Lowell astronomer, used the telescope to study comets. In 1955, the National Science Foundation recommended using the Pluto plates and the telescope to make a "proper motion study." Henry Giclas would also be involved with that project.[39]

Post-War Changes

The war years of 1941-1945 brought on a number of technological changes in the field of astronomy. For example, the photographic techniques used in discovering Pluto were ushered out and means of gauging stars electronically were developed.

As electricity spread across the country in the post-war decades, light pollution became an increasing problem for observatories. In response to this problem, the Lowell Observatory opened a "dark sky" site at Anderson Mesa, twelve miles south of Flagstaff.[40] In 1970, the 13-inch A. Lawrence Lowell telescope was removed from the Pluto dome and sent to Anderson Mesa. Another telescope was placed in the Pluto dome and it remained there until 1994 when it was removed to an exhibit in the.Observatory's new Steele Visitors Center. The Pluto telescope returned to Mars Hill in 1994 to be restored to the Pluto dome.[41]

The Pluto dome is one of the most popular visitor attractions at the Observatory. Visitors reach the dome by way of the "Pluto Walk," a sidewalk built in 1990 with signs showing each of the nine planets in our solar system. The path runs between the Administration building and the dome and closely follows the path used by those astronomers who used the 13-inch telescope to search for "Planet X."[42]

PART II: ARCHITECTURAL INFORMATION

A. General Statement:

1. Architectural character: The Pluto dome is a small, cylindrical building constructed out of local materials. The structure is utilitarian and does not conform to any "traditional" style of architecture, however the interior woodwork is done in the craftsman style. The shape of the dome is that of an "inverted bucket," and is similar in shape to the Lowell Observatory's 1896 Clark dome. The inverted bucket shape is unusual, as most astronomical domes were, and continue to be, built in a hemispherical shape.

2. Condition of fabric: This structure is currently being restored and was in poor condition prior to restoration work.

B. Description of Exterior:

1. Overall dimensions: The structure is cylindrical and has two stories. It is 34' high and 26' in diameter at the base and tapers to 21' at the top of the dome. The first floor is an open room where the bases of the telescope piers are visible, and the second floor is where the telescope was mounted. There is a single entrance door on the south-east side and three first floor windows. The dome has two large double doors that open to allow stellar and planetary

observations. One door is on the dome's side, the other is on the top.

2. Foundations: It is unclear whether or not this building has foundations, and if so, what the foundations are made of. An early photograph taken during the initial stages of construction shows excavation being done in the area where the dome would be erected. However, subsequent construction photographs are unclear as to whether workmen were digging to provide a foundation for the entire building, or for the heavy, concrete telescope piers alone. According to Henry Giclas, Lowell astronomer since the 1930s, some of the Observatory's buildings were constructed without foundations.

3. Walls: The first story base is covered with local malpais volcanic rock. The stone is placed randomly, except for deliberate arches over windows and doors. The dome and its doors are covered with raised seam metal sheeting painted white. The strips are joined with rivets and each joining point has a peak the vertical length of the seam, creating a corrugated appearance.

4. Structural Systems: The walls of the lower story are concrete. Based on early photographs taken during construction, wood forms were created and concrete was poured inside. A veneer of local Malpais volcanic rock was placed over the concrete. The dome has a wood frame, likely of local ponderosa pine.

5. Openings:

a. Doors: There is a single entrance door on the first floor, south-east side. The door is made of wood painted white with six panels; four on the bottom with two lights above. The top of the door frame has a slight arch. (The observation doors on the dome are described in the mechanical section)

b. Windows: There are three pairs of casement windows on the first floor, and a single, smaller pair of windows in the stairwell higher on the east wall. Each individual first-floor window has a single pane, but earlier photographs of the building show two-light casement windows. The window sills are plain rectangular concrete slabs. The window frames are slightly arched.

6. Roof: The dome roof is shallow and conical in shape. The support structure is wood frame, with beams fanning out from the center. There are two observation doors on the dome. One door is on the side and the other covers a rectangular section of the top from the roof edge to a point through and just beyond the center. Next to the doors are a system of poles and railings with ropes and pulleys, which allow the doors to be opened and closed from inside the dome. Also on the roof is a square "cupola" with a stacked gabled roof and a small, square door opening on the north side. The cupola is also covered with corrugated metal sheeting painted white. Around the perimeter of the dome's roof is a thin metal railing.

C. Description of Interior:

1. Floor plan: The first and second floors are circular. The first floor has a concrete "platform" approximately 6' high inside the southeast doorway. The platform is square except for the south edge that curves in accordance with the outside wall. To the right side of the platform is a curved wood staircase leading to the second floor. There is a wood railing around the platform with a small gate opening opposite the door. The gate allows one to step down to the floor. The stair railings match the platform railings--plain, with squared wood balusters painted white and a gray top wood rail. The stair railings extend from the lowest level of the first floor to the guard railing on the second floor and therefore cover a large section of the east side of the first floor.

Also on the first floor are the bottoms of the concrete telescope piers, or supports. The one next to the north wall is pyramidal, and the one on the south wall is more rectangular. Near the west wall is a rectangular elevator made of metal with two metal beams on the sides that run up and through to the second floor for lifting telescopes and equipment to the second floor.

The second floor is empty except for the concrete telescope piers near the north and south walls, and a trap door for the elevator near the west wall.

2. Flooring: Flooring on the first floor is concrete. On the second floor, commercial carpeting covers a floor of 6" wide ponderosa pine, boards running north/south.

3. Walls: On the first floor, the walls are of unfinished concrete. The ceiling shares the exposed pine flooring and joists of the second floor. The second floor walls are concrete up to the beginning of the dome. The walls of the dome are unfinished planks of ponderosa pine laid diagonally, with an intricate system of wood cross-bracing. The ceiling is done in the same manner, with the bracing joists arranged to fan out from the dome center.

4. Openings: There are no interior door or window frames in this structure.

5. Hardware: The doorknob on the main south-east door has a rectangular plate, round metal doorknob, and a keyhole beneath. Window latches are two part, rectangular metal latches with a small oval knob on one side, and a hollow rectangular catch on the other. When the knob is turned, a small bolt moves in or out of the hollow catch.

6. Mechanical equipment: There are two pairs of observation doors on the dome that open to allow stellar and planetary observations. One pair of doors is on the side, extending from near the edge of the dome roof to the top of the stone-covered first story. The other pair is on top of the dome, running from the top edge of the side doors, through and just past the center top of the dome. The observation "cupola" meets the upper doors at this point. Surrounding both doors on the roof are metal support poles with ropes and pulleys to allow the observation doors to be opened and closed from inside the dome. Inside the dome, below the side observation doors, is a wood rack for tying the ropes to hold the doors open.

7. Original furnishings: The 13-inch telescope originally housed in this building, although removed, is still at the observatory.

D. Site:

1. Historic Landscape: The Pluto Dome is located on a small rise on the northern edge of the Observatory property. Astronomers using the dome over the years beat a path between the Administration building and the Pluto Dome. This path, running northwest to southeast up the hill has been paved and is known as the "Pluto Walk." The path is currently traveled by visitors to the site, and also passes by Percival Lowell's tomb.

PART III. SOURCES OF INFORMATION

A. Architectural Drawings: A new set of blueprints was drawn for the Pluto dome in the late 1980s. This set was drawn for use in the restoration of the dome. Archives, Lowell Observatory, Flagstaff, Arizona.

B. Early Views: There is an extensive set of photographs of the Pluto dome at all stages of construction from ground breaking to completion, 1928-1929. There are also photographs of the dome interior, second floor, showing the 13-inch A. Lawrence Lowell Telescope in place. These photographs are contained in photo album number 6 which is stored in the basement vault of the Lowell Observatory Administration Building.

C. Interviews: Robert Millis, Director, interview with author, July 16, 1994. Lowell Observatory, Flagstaff, Az.

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PART IV. PROJECT INFORMATION

The Lowell Observatory Recording Project was sponsored by the Arizona State Historic Preservation Office, Kenneth Travous, Executive Director, and Lowell Observatory, Robert Millis, Director. The documentation was undertaken by the Historic American Buildings Survey division of the National Park Service, Robert Kapsch, Chief, with Joseph Balachowski, Architect, and Catherine Lavoie, Historian, supervising. The project was completed in the summer of 1994 at Lowell Observatory, Flagstaff, Arizona. The recording team included Maggie Ross, team supervisor, Christina Radu, Schaeffer Somers, and Tom Hetrick, architect technicians, and Rebecca Jacobsen, historian. Rebecca Jacobsen conducted all research relating to the project and completed the historic structures reports, with Catherine Lavoie editing. Site photographs were taken by Brian Grogan.

Notes:

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Vesto Melvin Slipher, letter to Poger Lowell Putnam, 30 June 1927, Archives, Lowell Observatory, Flagstaff, Arizona, Vesto Melvin Slipher Letters.

Vesto Melvin Slipher, letter to Poger Lowell Putnam, 18 February 1928, Archives, Lowell Observatory, Flagstaff, Arizona, Vesto Melvin Slipher Letters.

Vesto Melvin Slipher, letter to Poger Lowell Putnam, 11 January 1928, Archives, Lowell Observatory, Flagstaff, Arizona, Vesto Melvin Slipher Letters.

Vesto Melvin Slipher, letter to Poger Lowell Putnam, 9 April 1928, Archives, Lowell Observatory, Flagstaff, Arizona, Vesto Melvin Slipher Letters.

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Robert Millis, interview with the author, 16 July 1994.

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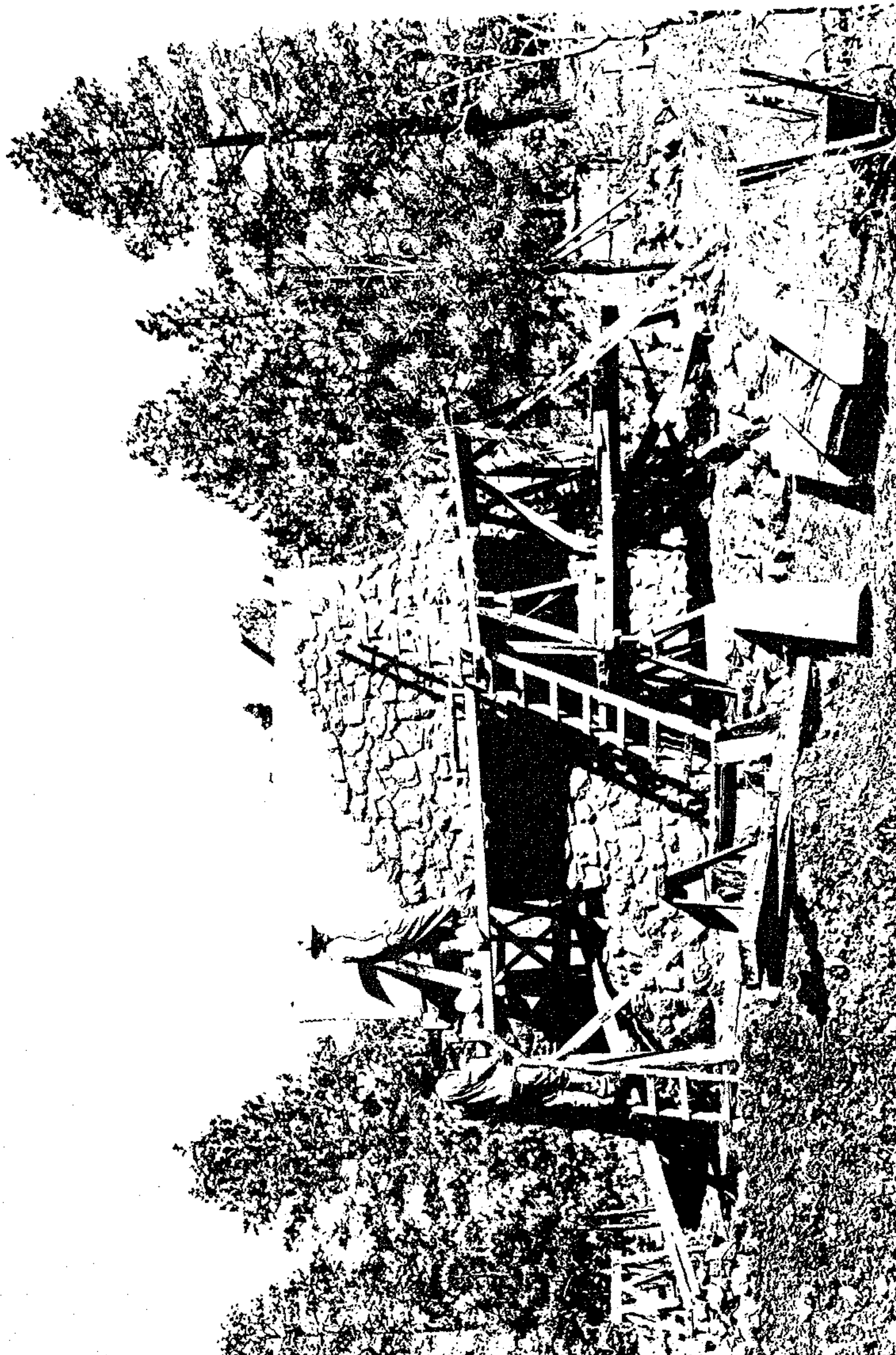

Figure #1 Photograph, Construction of the Lowell Observatory Pluto Dome. Archives, Lowell Observatory, Flagstaff, Arizona, 1929.

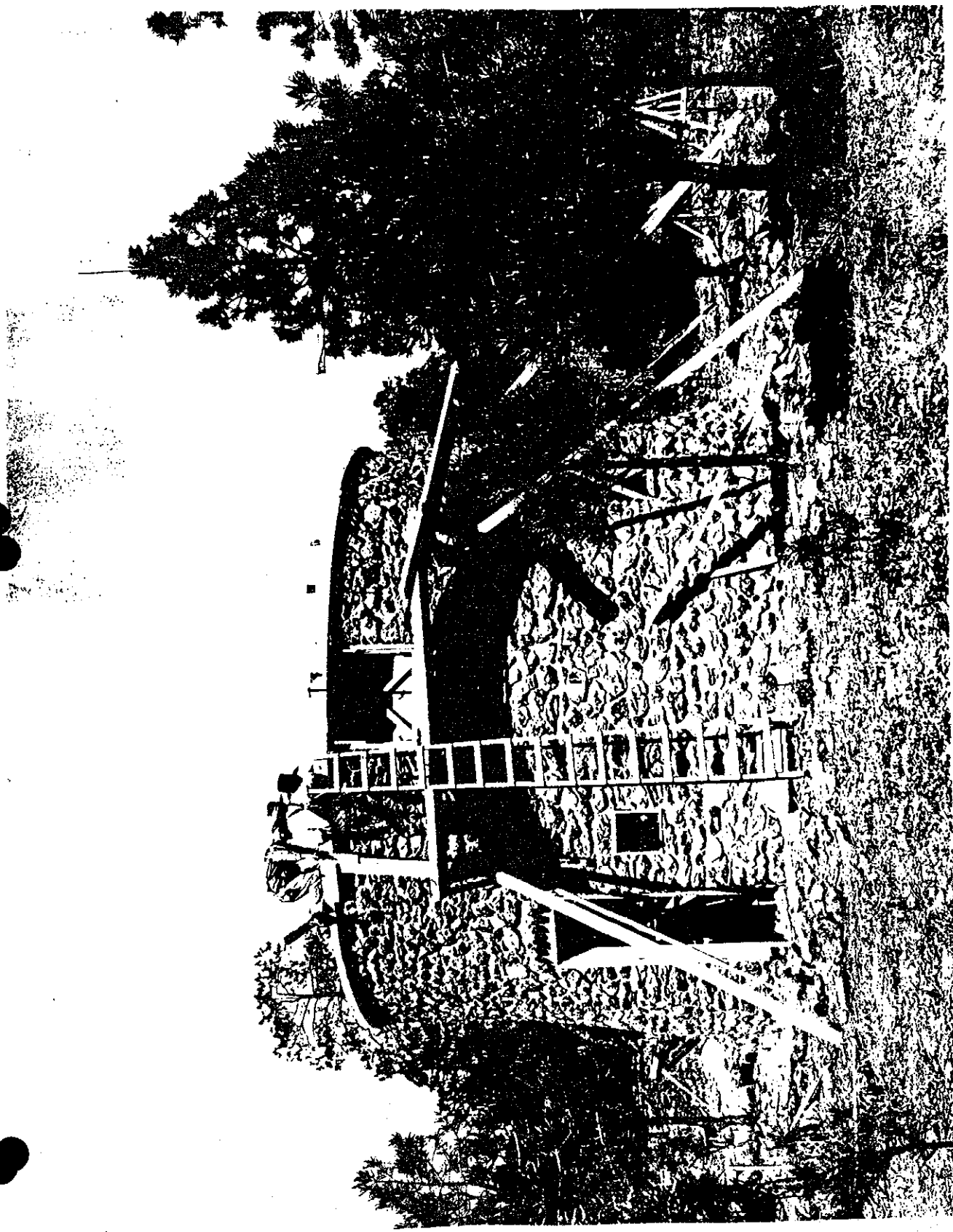

Figure #2 Photograph, Construction of the Lowell Observatory Pluto Dome. Archives, Lowell Observatory, Flagstaff, Arizona, 1929.